Real-Time fMRI Neurofeedback Protocol for Down-Regulating the Dopaminergic Midbrain

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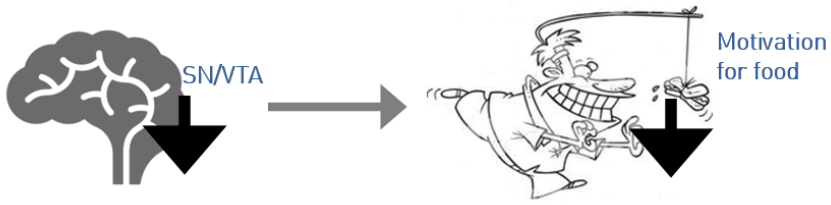
Introduction

The difficulty for people to make healthy eating choices in today's society of abundance can lead to obesity and associated health issues in the long run. These eating patterns are influenced by the brain regions substantia nigra and ventral tegmental area (SN/VTA). It has been hypothesized that tuning down the SN/VTA activity is a possible way to decrease the intrinsic motivation towards food and help people make more sensible eating choices.



Real-time fMRI Neurofeedback (rt-fMRI NF) is a training method with which participants can learn to regulate brain activity in predefined brain regions such as the SN/VTA.

Aim

- Explore the functioning of the self-written neurofeedback protocol for down-regulating the SN/VTA in a feasibility study with five participants
- Examine effects of different feedback designs on the participants

Methods

Participants

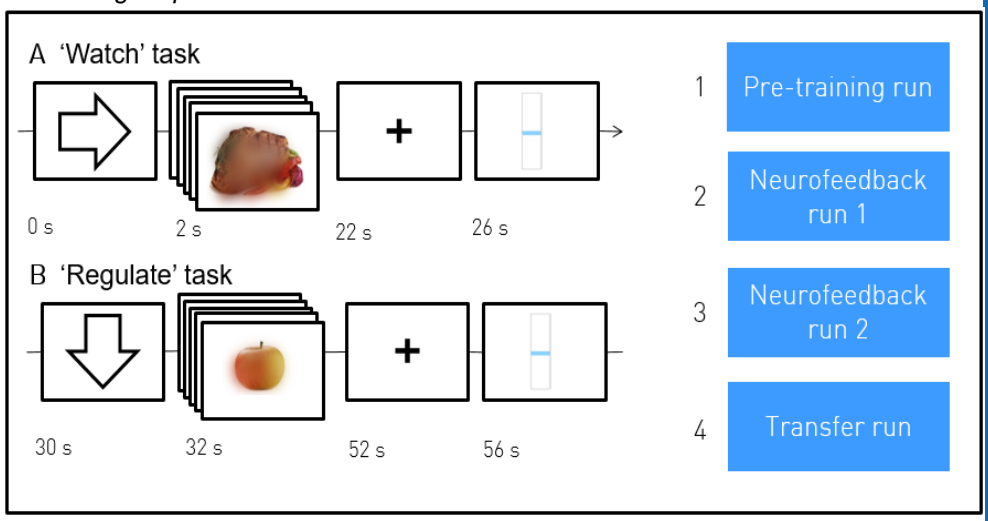
- N = 5 (male, mean age = 28.2 years, mean BMI = 24.8 kg/m^2)
- Inclusion criteria: right handed, non-smoking, no food allergies and/or not following a special diet
- Required to fast for at least 4 hours before the two training sessions, within the same week

Experimental procedure

Forms and Questionnaires:

- Prospective Consumption
- Positive And Negative Affect Scale (PANAS)
- Neurofeedback questionnaire

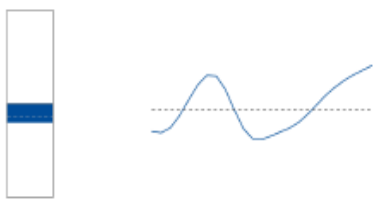
Training sequence



The sideward arrow is the cue for the 'watch' task, where the participant passively watches the food images. During 'regulate', he tries to suppress his appetite while looking at the food. The neurofeedback shows the brain activity of the SN/VTA (ROI) during the presentation of the food images.

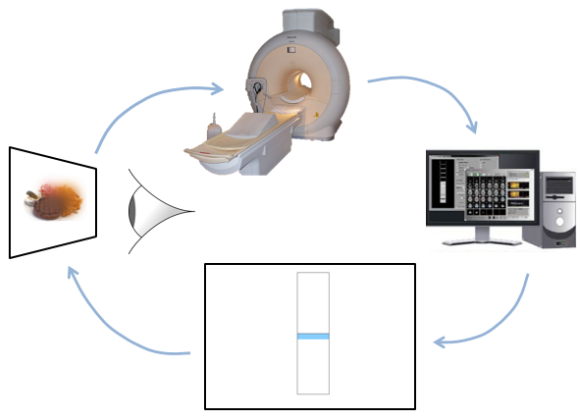
Feedback design

- Thermometer vs Graph
  - Representing average PSC or course in time
- Real-time updating target line to adjust to the participant's level and to test any differences in motivation



Real-time fMRI Neurofeedback

- It is a non-invasive, endogeneous training method for the self-regulation of diverse brain regions
- Brain activity during a task is measured and returned to the participant.
- Through several iterations the participant trains his ability to regulate brain activity.
- Following operant conditioning, the type of feedback and reward influences learning considerably



Results

Questionnaire results

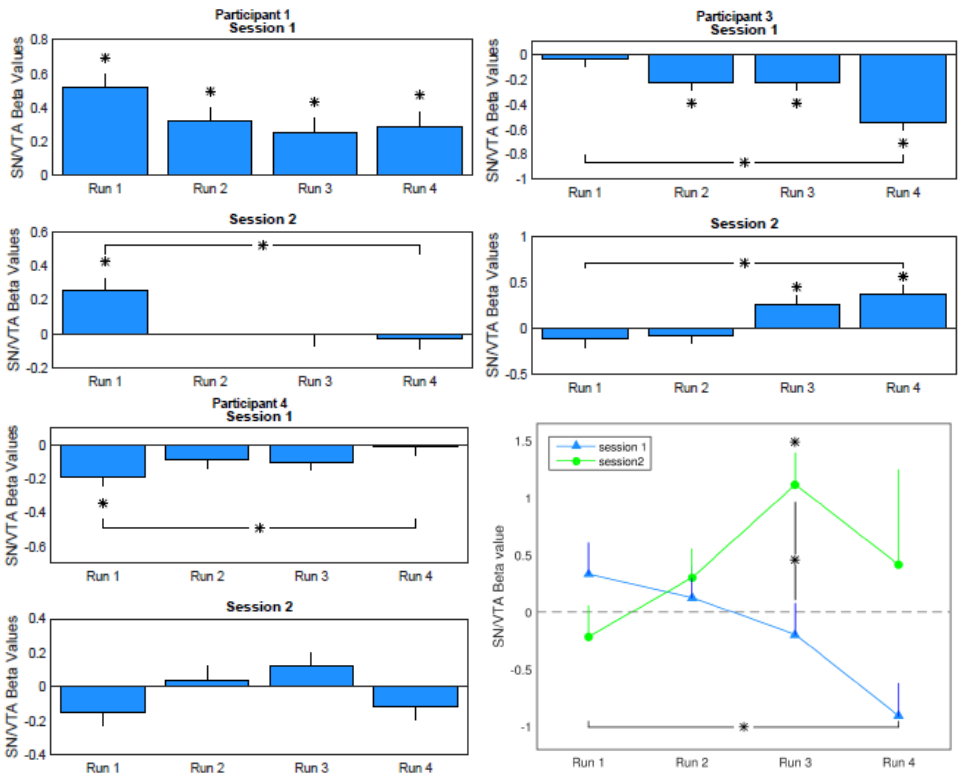
Feedback design:

- Equally positive reactions to both feedback designs
  - Add a frame of reference to the graph feedback
  - Improve coherency of thermometer feedback
- Increase the success rate of the target line

Experiment setup:

- Decrease the duration of the scanning time
- Separating the training into sessions improved learning

VOI postprocessing results



Conclusion

We have shown the feasibility of rt-fMRI NF assisted down-regulation of the SN/VTA during visual stimulation with food pictures. We also learned ways to improve the training design, which, if successful, can have far reaching applications from supporting healthy eating choices to the treatment of eating disorders.

References

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